INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

BLOCKCHAIN-BASED MUSEUM ASSET MANAGEMENT SYSTEM

Meshal Bin Falhan Bin Muflih AL Osimi
College of computer science and information technology, Shaqra
Email : mesh3al.144@gmail.com

Amjad Aldweesh
College of computer science and information technology, Shaqra University
Email : A.aldweesh@su.edu.sa

Abstract

The development of Blockchain technology has been game-changing for various stakeholders across technological, financial, and business fields. The new technology has shown the massive potential that allows for its use in a variety of businesses. Blockchain technology refers to a type of record-keeping technology that makes use of “blocks” or information in digital form that is then connected through “chains” to public databases. These chains will then create a network that is decentralized and eliminates the need to have a third-party trustee, as all the information stored may be publicly verified. An additional feature of block chain is the ability to enforce “smart contracts,” which are terms coded into the Blockchain that can execute themselves when specific conditions are met. This guarantees that while accessing information from the Blockchain, it is confirmed that the data has not been changed. Blockchain technology can be used on some systems within the museum industry in need of renovations, whether that’s in regard to ease of use, accuracy, or accessibility. Block chain would be the key that brings both historic and modern institutions into the modern age. Given the continuous development and application of Blockchain technology as witnessed in world trends, the academic and commercial circles are actively exploring the research directions and practical application of Blockchain to develop cryptocurrency and other applications where the Blockchain has already played its advantage. The thesis will thus seek to establish how Blockchain technology can be used to implement a museum asset management system to preserve artifacts through an investigative study. This paper will primarily focus on research that has been conducted on Blockchain technology and its applications to the field of artifacts property, analysis of the academic research and the commercial applications that have been carried out in this regard, and suggest a new feasible solution towards the research and development of the Blockchain technology.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

Introduction

Blockchain technologies have widely been embraced in the current technological world, with a wide number of sectors embracing the technology for its vast applications [1]. This adoption is attributed to how Blockchain technologies allow these sectors to perform fast operations that are quick, safe, secure, and have transparency [2]. Moreover, Blockchain technology addresses the key concerns of the security of transactions, especially online, that have become the trend in the new technological age [2]. This is especially so due to the lack of proper channels to transmit secret and confidential data that, should an organization be subjected to cyberattacks, would suffer greatly [3]. However, due to the lack of completely secure and proven Blockchain technology, organizations still remain hesitant to use the technology for most of their data transfer operations. Sadly, most organizations are still largely unaware of the capabilities and benefits of using Blockchain technology, which is not only evolutionary but has endless capabilities for further development in many organizations.

Moreover, archaeologists suffer from the loss of stolen pieces that are sold illegally and rejected by many museums as some pieces are of unknown origins due to the consequent policies and ethics, and for this reason, many artifacts are lost, and their identity lost [4]. Preserving each piece is preserving the heritage that, once permanently preserved, can be accessed at any time [5]. One of the ways to preserve it continuously is to use modern technologies to create an ease in the identification of art pieces and trace their origins efficiently. Therefore, this research contributes to the enhancement of Blockchain technology to allow for the preservation of the cultural heritage of countries in the creation of a museum asset management system based on Blockchain technology. In the heritage aspect, it will aid in preserving the artifact in museums around the world and those owned by private and interested organizations as well as individuals; this technology will enable each art piece to be registered with a serial number and to be preserved permanently and sold systematically through smart contracts, as well as displaying the pieces to all museums and individuals.

Literature Review

2.1 Background

Since the creation of the first computers, the development of computer networking has undergone great evolutions that have led to the development of technical ideas has allowed for the mainstream extension of computer networking systems [6].

ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

Since its creation, the world wide web (WWW) has allowed for the connection of millions of persons across continents, which has made communication much easier and revealed endless possibilities for the transfer of data in the last thirty years.

Initially, the world wide web was a static nature that consisted of webpages that were plain consisting of texts and images that popped out of the computer screens representing the host's intent and perspective to its views with little interactivity capabilities [7]. The web version known as Web 1.0 was more similar to traditional channels of mass communication such as television broadcasts and offered minimal content. These websites were built using static HTML pages that would be stored in files, and very few of these websites made use of embedded styles. Following the huge demand for an online presence by organizations, businesses, and individuals, the web pages have since evolved to create a more interactive webpage that allowed users that flocked to these websites to contribute content and generate content [8,9]. With developments being made on these web pages, web browsing was made easier and data transmission a plausible reality within the newer web version 2.0 that had no separate boundaries but fundamental principles and practices.

In recent years, there have been even more significant advancements in the world wide web with the release of new software that has allowed software developers to create more interactive and vivid websites that incorporate more agile and ongoing methodologies such as Software as a Service (SaaS) approach that allows one to undertake the incorporation of the value of data [7]. This software and methodologies have created a platform that allows for a platform for one to engage in from work and finance to social relationships and entertainment; every aspect is affected by the impact of data filling human lives through the internet. In the new global economy, digital growth is a significant indicator.

2.2 Blockchain Technology

Blockchain refers to a document that is full of entries shared by a group of people or organizations. The entries are related to the people and organizations that share them. These entries would thus represent the items, or currency values exchanged between entities [1]. To ensure the security of these entities, the shared document is encrypted and then verified to ensure the data stored reflects the correct values to all involved parties [2,10]. Everyone that shares the full document within the group or organization can validate the transaction between them, thus eliminating the need for a central authority such as a bank, law enforcers, a judge, or arbitrator. As such, transactions that occur between the parties are transparent and open to both entities.

ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

This allows for the creation of better trust and elations; the entries are immutable: once created, they cannot be updated or deleted. They cannot be tampered with [11]. The idea of Blockchain was originally described by Satoshi Nakamoto in Bitcoin white paper in 2008. Satoshi's identity remains unknown; he engaged with the Bitcoin community solely through online forums and other written media; he may be a single person or a group of people working on the Blockchain concept. The words block and chain were used independently in Satoshi Nakamoto's initial paper but were subsequently popularized as a single word, Blockchain, by 2016. [9]

A distributed database that is shared among the nodes of a computer network is known as a blockchain. As a database, a Blockchain stores digital information electronically. Blockchains are most recognized for their indispensable function in cryptocurrency systems, such as Bitcoin, for keeping a secure and decentralized ledger of transactions [1]. A Blockchain's novelty is that it ensures the fidelity and security of a data record while also generating confidence without the requirement for a trusted third party.

The way data is structured differed significantly between a traditional database and a Blockchain. A Blockchain organizes data into groupings called blocks, each of which contains a collection of data. Blocks have specific storage capabilities, and when they're full, they're closed and linked to the preceding block, producing a data chain known as the Blockchain [1,2,3,11,12]. All additional information added after that newly introduced block is compiled into a new block, which is then added to the chain after it is filled. Blockchain could be utilized in detecting counterfeits by assigning unique IDs to products, papers, and shipments and preserving records connected to transactions that cannot be falsified or altered. It is argued, however, that Blockchain technology must be supplemented with technologies that create a strong connection between actual items and Blockchain systems [11, 12]. The EUIPO organized an Anti-Counterfeiting Blockathon Forum with the purpose of "defining, piloting and implementing" an anti-counterfeiting infrastructure at the European level. To authenticate certificates, the Dutch Standardisation Organisation NEN employs Blockchain in conjunction with QR Codes [14].

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

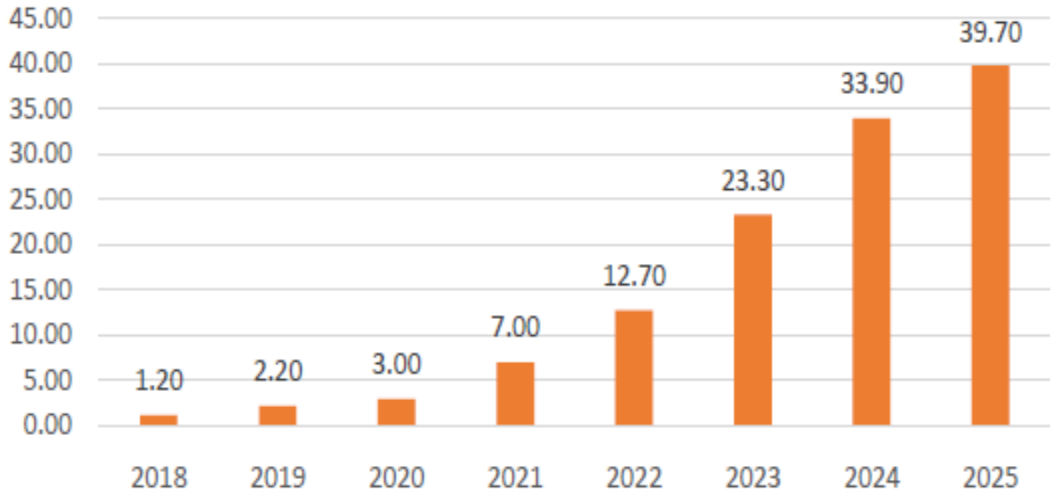

Figure 1: Chart of the market growth of Blockchain technology in the world in USD billions [9].

2.3 Block creation.

Repeatedly, new blocks are generated in the dispersed network. Every node can submit its transactions to a common pool, but only those that fit into the next block are added to the chain. Mining is the process of creating a new block in a Blockchain network and having it signed as the next block in the chain, and miners are the peers who engage in this process [15,16]. Mining is a portion of Blockchain's security process that creates a competitive ecosystem in which all miners are attempting to validate data and verify that every other miner has correctly mined a block [17]. Consequently, validating blocks is frequently rewarded by the network. In addition, it is not uncommon for participants to include a transaction fee to encourage miners to prioritize their transactions above others while generating the subsequent block. In order for the peer-to-peer network to function without trusted intermediates, the task of maintaining the distributed ledger must provide sufficient incentive for miners [16]. As incentives, network rewards and transaction fees are often distributed by Blockchain protocols using a native cryptocurrency. Depending on how consensus is reached on a given network, the mining procedure can vary substantially between models.

2.4 Consensus models

Consensus models refer to the mechanisms that govern how a decentralized, trustless Blockchain network finds consensus. This agreement typically specifies which block will be attached to the Blockchain. There have been numerous models created

ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

over time, including Proof of Work (PoW), Proof of Stake (PoS), Proof of Authority (PoA), and Delegated Proof of Stake (DPoS). Following are descriptions of the first two most renowned cases [18].

2.5 Technologies Used

Ethereum

Ethereum is a decentralized, open-source blockchain platform that supports smart contract functionality [19]. Ethereum is a permissionless, non-hierarchical network of computers (nodes) that construct and reach consensus on an ever-expanding series of "blocks" or transaction batches known as the Blockchain. Each block includes an identifier of the chain that must precede it in order for the block to be valid. Whenever a node adds a block to its chain, it executes the transactions contained within, thereby modifying the ETH balances and other storage values of Ethereum accounts. These balances and values, collectively known as the state, are stored in a Merkle tree on the node's computer, apart from the Blockchain. Merkle tree is a binary tree composed of cryptographic hash pointers; therefore, it is a binary hash tree. It bears the name of its inventor, Ralph Merkle. Merkle trees are constructed by hashing paired data (typical transactions at the leaf level) and then hashing the hash outputs all the way up to the Merkle root [20].

Each node communicates with its peers, a relatively small subset of the network. When a node wants to add a new transaction to the Blockchain, it sends the transaction to its peers, who then forward it to their peers, and so on [19]. This is how it spreads throughout the network. Certain nodes, known as miners, maintain a list of these new transactions and use them to generate new blocks, which they then transmit to the rest of the network. Whenever a node receives a block, it verifies the block's and its transactions' validity and, if found to be valid, adds the block to its Blockchain and executes all of its transactions [20,21]. Due to the non-hierarchical nature of the network, a node may receive competing blocks that may form competing chains. Following the "longest-chain rule," which states that the chain with the most blocks at any given time is the canonical chain, the network reaches consensus on the Blockchain [19]. This rule achieves consensus because miners do not want to expend computational effort attempting to add blocks to a chain that the network will abandon [22]. The Ethereum network enables the development and execution of decentralized applications and smart contracts [23].

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

Ethereum Virtual Machine

While executing instructions, the Ethereum Virtual Machine (EVM) modifies the global singleton state. [24] The EVM is the runtime environment in which Ethereum transactions are executed. It includes a stack, memory, gas balance, program counter, and persistent storage for every account (including contract code). When a transaction calls the function of a contract, the EVM translates the contract's bytecode into EVM opcodes, which it then executes on the stack. Stack items may be stored in memory or account storage, and data may be added from memory/storage. The EVM is isolated from other files and processes on the node's computer to ensure that, for a given pre-transaction state and transaction, each node generates the same post-transaction states, enabling network consensus. [22] Developers of Decentralized Applications (DApps) typically write smart contracts for the Ethereum Blockchain in a high-level programming language before compiling them into bytecode [20]. The Ethereum bytecode is subsequently deployed on the Blockchain and executed by the Ethereum Virtual Machine (EVM).

Solidity Programming Language

Solidity is a high-level, object-oriented language for implementing smart contracts. Smart contracts are computer programs that govern the behavior of Ethereum accounts. Solidity is a language with curly brackets. It is designed to run on the Ethereum Virtual Machine and is influenced by C++, Python, and JavaScript (EVM). Solidity is statically typed and supports, among other features, inheritance, libraries, and complex user-defined types. Solidity code is written in files with the extension.sldy (.sol). They are text files that are readable by humans and can be opened in any text editor, including Notepad. Solidity permits the creation of contracts for applications such as voting, crowd funding, blind auctions, and multisignature wallets. [25]

Application Development

3.1 Creating a Blockchain Network

For the purpose of this paper, the researchers used Hybrid Blockchain network as the core blockchain architecture. The parties involved in this network include:

- Private Museum
- Public Museum
- Contributor
- Transporter

ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

- Buyer (if any)

A Blockchain-based solution can unite these parties in a P2P network that eliminates all risks and creates a transparent system [1,2,11]. All network participants will have access to synchronized information from the shared, immutable ledger and be able to monitor the movement of assets. The Blockchain ledger will record the order of all current activities [21]. Typically, each network participant maintains their own copy of the Blockchain, which is synchronized with the network's smart protocols and technical layers. All transactions throughout the process are recorded in the general ledger [3, 26, 13].

3.2 Business types selection

After establishing the Blockchain network, the next step was to determine the type of business transactions that will occur within the Blockchain architecture. Typically, these regulations are codified in legal contracts. These agreements are written in the form of smart contracts in the Blockchain code. Identical to conventional contracts, Blockchain contracts include parties, assets, and transactions. For each transaction, a transactional processor function describing what occurs after the transaction is created is written.

3.3 Writing Smart contract

The smart contract was written using the Solidity programming language in order to record the specifics of each unit. The code is first developed using Solidity language a well-known programming language to write Blockchain codes. Once the program was ready, it was compiled into a smart contract with the help of the solidity compiler. After compiling the code, we have the byte code (opcodes) which is sent to the Blockchain using Ethereum transaction. This code is triggered any time by sending a transaction to its address

To accomplish this, we first configured our development environment. The researchers utilized Remix IDE, an open-source IDE, for Solidity DAPPs as shown in figure 11.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

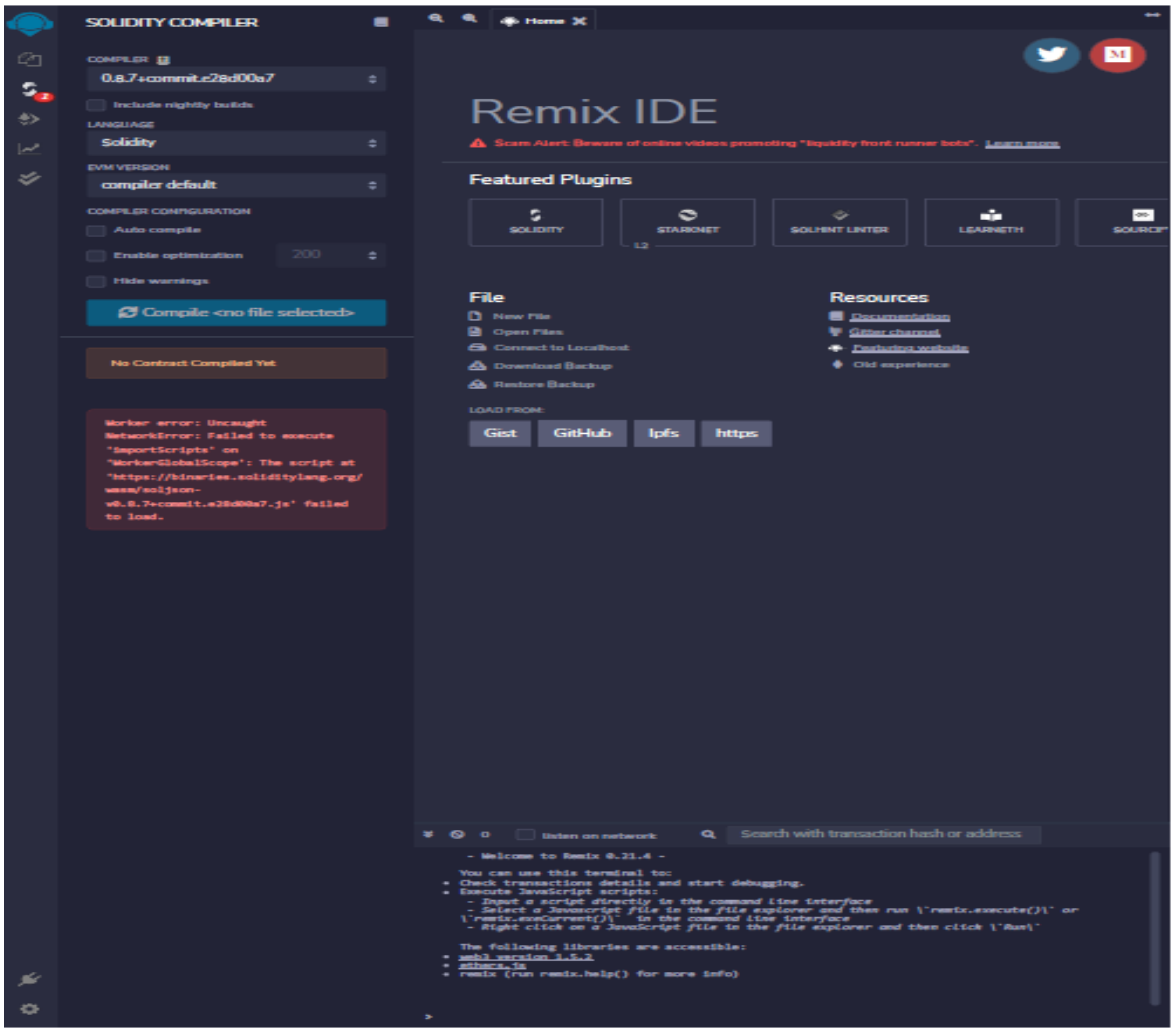

Figure 11: SOLIDITY COMPILER WINDOW (https://remix.ethereum.org)

This application utilizes four smart contracts, the first contract records the assets with the four basic attributes: number, name, location, and price. These attributes can be retrieved using retrieve function that returns the attributes for an asset. The second contract is to register each asset to an owner and also to check who owns which and what. The third contract's main purpose is to auction assets and works as follows: the auction process opens for a given period of time. During this time, buyers have the window to place their bids. After a predetermined time, this window closes and no further bids are accepted. The highest bids wins and ether are transferred directly. The fourth contract is similar to the third but there is no time limits to place bids.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

Conclusion and Future Works

4.1 Conclusion

The evolution of Blockchain technology is exceptionally rapid. To track the state of the art, it is essential to comprehend the fundamental components of the technology and their interrelationships. This paper demonstrates the use of Ethereum Blockchain as a decentralized computer and storage medium for smart contracts. The manner in which the world operates is destined to change as a result of the continued development of technology in a vast array of fields and industries. However, it is not devoid of obstacles; some of them have been highlighted. The preceding study suggests that Blockchain technology aids in the preservation of artifacts. It can be implemented in this industry to prevent fraud and counterfeiting. The second section of this dissertation proves our case by writing Solidity language source code for a decentralized application, demonstrating that it is possible to preserve artifacts using Blockchain technology.

4.2 Challenges

Developing a system based on smart contracts of this magnitude requires a highly specialized development model. But current smart contracts – conceived on Ethereum as a solution to a problem – have failed to provide what developers need for mass adoption. The following are the primary obstacles:

• The adoption curve: To transform the current transactional environment, which is characterized by a steady, high-volume stream of records entering the system, businesses must overcome numerous obstacles.

• Governmental concerns: How should the government govern this contract? How would the government tax transactions involve smart contracts?

• Difficult to modify: Changing smart contract processes is nearly impossible, and any error in the code can be costly and time-consuming to fix.

• Potential for loopholes: According to the concept of good faith, parties to a contract will deal fairly and not gain unethical benefits. However, the use of smart contracts makes it difficult to ensure that the agreed-upon terms are met.

• Third party: Although smart contracts attempt to eliminate the involvement of third parties, this is not possible. Different roles are played by third parties compared to traditional contracts.

The hype surrounding Blockchain, cryptocurrencies, and smart contracts has led enthusiasts, the general public, and organizations to believe that smart contracts applications are impractical.

ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

4.3 Future Work

The evolution of decentralized applications proved too extensive for a single dissertation. This study paves the way for additional future opportunities regarding provenance and how to improve this solution for the museum industry. It is recommended that the research should focus on improving the data collection at the source, provide a more secure method for item tagging, and implement the majority of this solution on the Blockchain network. We would also like to develop user interface design for the museum Dapp and make it available for free download and use by consumers.

References

1. Crosby M, Pattanayak P, Verma S, Kalyanaraman V. Blockchain technology: Beyond bitcoin. Applied Innovation. 2016 Jun;2(6-10):71.
2. Brito J, Castillo A. Bitcoin: A primer for policymakers. Mercatus Center at George Mason University; 2013 Dec 19.
3. Klerkx, Laurens, and David Rose. "Dealing with the game-changing technologies of Agriculture 4.0: How do we manage diversity and responsibility in food system transition pathways?." Global Food Security 24 (2020): 100347.
4. Kong L. Cultural icons and urban development in Asia: Economic imperative, national identity, and global city status. Political Geography. 2007 May 1;26(4):383-404.
5. Evans G. Hard-branding the cultural city–from Prado to Prada. International journal of urban and regional research. 2003 Jun;27(2):417-40.
6. Kolhe, Sanket. "Blockchain Based Smart Contracts for Business Process Automation." (2019).
7. Lee EM. A Proposal of Interoperability between Social Media and Blockchain-based Smart Contract System for Artwork Trading. Journal of the Korea Convergence Society. 2020;11(2):109-16.
8. Castells M. The Internet galaxy: Reflections on the Internet, business, and society. Oxford University Press on Demand; 2002 Oct 31.
9. Kleine D, Unwin T. Technological revolution, evolution and new dependencies: What's new about ICT4D?. Third World Quarterly. 2009 Jul 1;30(5):1045-67.
10. Lemieux VL. Trusting records: is Blockchain technology the answer?. Records Management Journal. 2016 Jul 18.
11. Wenker, Nicolas. "Online currencies, real-world chaos: The struggle to regulate the rise bitcoin." Tex. Rev. L. & Pol. 19 (2014): 145.

ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

12. V. Olena, KravchenkoSergey, HurochkinaViktoriya, Viktor P. Zvonar, Brechko V. Oleksandr (2020) Improving Public Administration by Blockchain Technologies
13. Pathak N, Bhandari A. IoT, AI, and Blockchain for .NET. Building a Next-Generation Application from the Ground Up. Apress. 2018.
14. Cusumano M. Cloud computing and SaaS as new computing platforms. Communications of the ACM. 2010 Apr 1;53(4):27-9
15. Bruce, J. D. "The mini-blockchain scheme." White paper (2014): 10.
16. Howard, Tiffiany, Brach Poston, and April Lopez. "Extremist Radicalization in the Virtual Era: Analyzing the Neurocognitive Process of Online Radicalization." Studies in Conflict & Terrorism (2022): 1-26.
17. Al-Housni, Nasser. "An Exploratory Study in Blockchain Technology." PhD diss., The University of Manchester (United Kingdom), 2019.
18. Yang, Fan, Wei Zhou, QingQing Wu, Rui Long, Neal N. Xiong, and Meiqi Zhou. "Delegated proof of stake with downgrade: A secure and efficient blockchain consensus algorithm with downgrade mechanism." IEEE Access 7 (2019): 118541-118555.
19. Hegedűs, Péter. "Towards analyzing the complexity landscape of solidity based ethereum smart contracts." Technologies 7, no. 1 (2019): 6.
20. Singhal, Bikramaditya, Gautam Dhameja, and Priyansu Sekhar Panda. Beginning Blockchain: A Beginner's guide to building Blockchain solutions. Apress, 2018.
21. Kochetkova, Marina. "BLOCKCHAIN IN THE ART MARKET: Opportunities and Challenges." (2020).
22. Bergquist, Jonatan. "Blockchain technology and smart contracts: Privacy-preserving tools." (2017).
23. Destefanis, Giuseppe, Michele Marchesi, Marco Ortu, Roberto Tonelli, Andrea Bracciali, and Robert Hierons. "Smart contracts vulnerabilities: a call for blockchain software engineering?." In 2018 International Workshop on Blockchain Oriented Software Engineering (IWBOSE), pp. 19-25. IEEE, 2018.
24. Kolhe, S. (2019). Blockchain Based Smart Contracts for Business Process Automation
25. Jan, Frait. "Generování Ethereum blockchain smart kontraktů z modelů DasContract." Master's thesis, České vysoké učení technické v Praze. Vypočetní a informační centrum., 2020.
26. Houtenbos, Mathijs. "Design Exploration of Transparency Enhancing Technology for Government." PhD diss., University of Amsterdam, 2016.